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Covenant-lite agreement and credit risk: A key relationship in the leveraged loan market

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ABSTRACT

In recent years, the leveraged loan market has experienced considerable growth, with the covenant-lite loan being the predominant agreement. The goal of this research is to assess whether the covenant-lite type reduces or increases the probability of default. Mediation analysis allows us to decompose the effect of balance sheet indicators on a default event into direct and indirect effects, the latter mediated by the covenant-lite. Results show that the covenant-lite is granted to borrowers with a greater profitability. In turn, all other conditions being equal, this agreement plays a role in making a default event less likely, giving rise to a significant indirect effect.

1. Introduction

The leveraged loan market has grown significantly in the last decade, supported by the search for yield by investors in a context of expansionary monetary policies. According to the European Banking Authority (2020), in 2019 issuance reached Eur 919.2bn in US and Eur 162.3bn in Europe. The COVID pandemic at the beginning of 2020 reduced the issuance of new loans (Eur 404bn for the US market and Eur 66bn for the European one), to then register a positive record in 2021 (LSTA, 2022). Since the COVID pandemic, the credit markets have greatly deteriorated (Goodell, 2020; Newton et al., 2020; Tampakoudis et al., 2022). The vulnerabilities associated with this growth include weaker credit quality of borrowers, a higher concentration of lenders within a lender type, liquidity risk and systemic risk due to interconnectedness in the financial system (Financial Stability Board, 2019; De Novellis et al., 2024).

The COVID pandemic has exposed risky credit markets to a combination of increased borrower leverage and weaker earnings. As reported by the European Central Bank (2020), both the high-yield and leveraged loan markets have experienced market declines close to two-thirds of the falls incurred during the global financial crisis, with marked consequences also for the liquidity of these instruments with exceptionally high bid–ask spreads. As a result, the rating agencies have reviewed creditworthiness, carrying out various downgrades. In addition, the deterioration in credit quality for leveraged loans has been pronounced in the last few years, with consequences also in the collateralized loan obligation (CLO) market. The concern has recently increased, given the

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rising inflation and interest rates in a new framework of monetary policy restrictions (BIS, 2022). In this context, lenders are strongly exposed to credit risk, and the event of default could impact capital adequacy ratios and increase the risk of capital shortfall (Fiordelisi and Marques-Ibanez, 2013; Bruche et al., 2020; Morais et al., 2022; Saona et al., 2023).

The leveraged loan is a type of syndicated loan characterized by a syndicate of lenders that jointly finance a highly indebted borrower with the aim of supporting general corporate expenses and particular operations, such as mergers and acquisitions (Bruche et al., 2020). The deal is previously promoted and managed by a single lender (or a small group of lenders) who coordinates the syndicate, as arranger. Financial covenants are typically included to monitor and test the performance of the borrower, and these allow the lenders to have a warning system if the company is failing to meet the financial performance projected before the conclusion of the senior facility agreement (Achleitner et al., 2012; Fox, 2023). If a breach occurs, it will constitute an event of default, giving lenders the opportunity to take remedial actions against obligors and to enforce the guarantees and collaterals of the loan. In particular, Roberts and Sufi (2009) find that technical defaults lead to a reduction of the leverage, while Nini et al. (2009) affirm that violations are associated with declines in investment spending. Despite the frequent use of such agreements, and evidence of the importance of including them in the transaction (DeFond and Jiambalvo, 1994; Dichev and Skinner, 2002; Franz et al., 2014), financial covenants are increasingly less frequent because of the presence of the so-called covenant-lite loan, a loan agreement that has fewer covenants than a traditional one (Becker and Ivashina, 2016).

The growth of the covenant-lite loans was interrupted in 2007 by the financial crisis, but in 2008–2009 was reconfirmed, increasing from around 25% in 2012 to more than 80% of leveraged loans on the market as of December 2021 (S&P Global Market Intelligence, 2022; European Central Bank, 2022), practically becoming a market standard. Banking authorities have expressed recurring concerns about the growth of covenant-lite loans, due to the decline in the role of banks to avoid an increase of credit risk (Federal Reserve, 2013; European Central Bank, 2017, 2018). The Financial Stability Board (2019) noted that newly issued leveraged loans are generally characterized by ever-decreasing credit quality, and that therefore the covenant-lite loans from this point of view could contribute to an increase of this risk. However, in recent years covenant-lite loans are the most widespread form in the market.

In this paper we are committed to understand the role of the covenant-lite agreement as a specific non-financial variable. Often "the devil is in the details" (IMF, 2016), and for this reason we try to understand if the covenant-lite agreement is a signal of more or less risk related to the leveraged loan. More precisely, we aim to understand the extent to which a covenant-lite agreement is granted on the basis of the riskiness of the loan and to assess whether this decision may itself play a role in the probability of default. This amounts to (a) appreciating the total effect of the balance sheet indicators measuring the financial stability of a company on the probability of default with the loan, and (b) disentangling this total effect into a direct effect and an indirect one, the latter mediated by the covenant-lite agreement. In doing this, we use mediation analysis (VanderWeele, 2015).

To the best of our knowledge, there are no studies in the literature on covenant-lite loans as informative signals with respect to traditional covenants regarding the credit risk profile. Our data shows that more than 80% of leveraged loans are covenant-lite (See Section 3), therefore it is of high relevance to study the impact of this kind of agreement on the probability of default. Extensive literature (see Section 2) defines banks as screeners able to reduce information asymmetries (Diamond, 1991), producing new signals (Allen and Santomero, 1997). In addition, it is the first time that mediation analysis has been applied to credit risk estimation, despite its widespread use in social science, psychology and biostatistics.

Overall, our paper relates to two different strands of literature. The first is the theoretical literature on syndicated loans for understanding the role of covenant-lite in contributing to the credit risk of loans (Sufi, 2007; Bosch and Steffen, 2011; Achleitner et al., 2012; Giannetti and Laeven, 2012; Franz et al., 2014; Becker and Ivashina, 2016; Cai et al., 2018; Bruche et al., 2020; Demerjian et al., 2020; Mählmann, 2022). This extensive literature is related to credit risk and the role of the financial intermediaries in reducing information asymmetries (Leland and Pyle, 1977; Diamond, 1984; Allen and Santomero, 1997). The second one concerns the literature on credit risk modeling (Crouhy et al., 2000; Lando, 2009; Bluhm et al., 2016; Thomas et al., 2017), proposing for the first time mediation analysis as an alternative to the various approaches already widely used in finance.

For this purpose, we use panel data for the period 2013–2019 concerning the compositions of the S&P European Leveraged Loan Index. In particular, data related to the instruments present in the index were integrated with borrowers' financial information to obtain a unique and original dataset that combines various sources of information for this market. Further, information on defaults that occurred in 2020 and the first three months of 2021 was added to the dataset to obtain the response variable for use in our models. The paper proceeds as follows. Section 2 lays out testable hypotheses. Data used in this paper are described in Section 3 with summary statistics for our sample of leveraged loans and for the concentration of these instruments in each country. In Section 4 we describe the methodology. Results are reported in Section 5, and Section 6 concludes and offers policy implications.

2. Hypotheses development

Banking authorities have expressed various concerns regarding the growth of the covenant-lite loan market (Federal Reserve, 2013; European Central Bank, 2017, 2018; Financial Stability Board, 2019; European Central Bank, 2022). These concerns are based on the assumption that the absence of restrictions does not allow a deeper control on the borrower and reduces the lender's ability to intervene. However, academic research on covenant-lite risk has produced mixed findings. Demerjian (2010) finds that covenant inclusion is positively associated with uncertainty prior to granting, suggesting that imposing financial covenants helps mitigate the risk associated with extending loans to borrowers with uncertain future performance. Billett et al. (2016) find that covenant-lite agreement is more likely with a less severe moral hazard and when bank relationship rents are high. Other studies (Becker and Ivashina, 2016; Berlin et al., 2020; Ivashina and Vallee, 2020) associate the growth of this agreement to the increasing participation of institutional investors that prefer to remove covenants based on periodically reported financial indicators to avoid verification costs. In line with this idea, Bozanic et al. (2018) and De Franco et al. (2020) show for the bond market that similarity in covenants' restrictiveness reduces costs and yield, and increases market liquidity. Gietzmann et al. (2023) find evidence of growing demand for risky debt investments with lower enforcement costs. This demand creates competition between investors, resulting in a growing presence of covenant-lite loans. Demerjian (2017) examines the use of financial covenants and finds that financial covenants are associated with greater uncertainty, providing a trigger for renegotiation when the borrower has a low credit quality. Similarly, do Rosário Correia (2008) and Cao and Xia (2021) show evidence of a negative relationship between the presence of covenants and lower creditworthiness.

We extent this line of research and, focusing on profitability as a key element of vulnerability (Nicoletti et al., 2022), we assess the following first hypothesis:

Hypothesis 1. The presence of the covenant-lite is significantly related to balance sheet indicators measuring either the vulnerability or the profitability of borrowers. Considering the prevalence of covenant-lite loans in the market, lenders may not grant covenant-lite agreements only to those borrowers who present a lower profitability.

In the strand of literature analyzing the effect of covenants on credit risk, Demerjian et al. (2020) examine the consequences of covenant-lite loans, finding that these ones are more likely to default than loans with financial covenants. Davydenko et al. (2020), in contrast, find that covenant-lite loans are not more likely to end up in default than other loans with similar leverage. Lemmon and Zender (2019) find that firms with significant amounts of debt will have very restrictive covenants that are renegotiated after violation. Most importantly, they show that the use of debt covenants transfers control to the lender for relevant decisions and, in this regard, they indicate that covenants increase the firm value only if renegotiated to eliminate the ex-post induced inefficiencies. The study highlights a possible creation of inefficiencies that could therefore be determined by the use of covenants. Trying to contribute to this debate, we test a second hypothesis, closely connected to the first one.

Hypothesis 2. The higher flexibility of the covenant-lite agreement imposes less financial burden on companies. Therefore, all other conditions being equal, there is a significant negative effect of the covenant-lite variable on the default event; i.e. the presence of the covenant-lite decreases the probability of default also when all other covariates are kept at a fixed level.

If Hypotheses 1 and 2 are true, through mediation analysis (VanderWeele, 2015), it is possible to understand the mediating role played by the covenant-lite variable in the pathway from the balance sheet indicators to the probability of default.

3. Data

Our original dataset combines data from three sources: (a) the composition of the individual instruments from the S&P Dow Jones Index, (b) financial data for each loan collected through Orbis (Bureau van Dijk) and (c) loan default events from Bloomberg. Our initial S&P sample contains the compositions of the S&P European Leveraged Loan Index for the period 2013–2019, considering 2280 leveraged loans. For the purpose of our work, we focused on the compositions as of 31 December 2019. Starting from this sample, the default status has been verified from 1 January 2020 to 31 March 2021, by adding to the initial dataset a binary variable with the value 1 if the loan defaulted, and 0 otherwise. The total sample includes 344 loans, of which 4.65% were in default. In line with other market loans, a default event is relatively rare. Techniques, based on data augmentation, that are standard in the credit scoring context, will therefore be used before applying the logistic model; see Pierri et al. (2016) and Sun et al. (2018).

The initial information on the S&P compositions concerns in particular the following characteristics: country of domicile, currency, Bloomberg Industry Classification System (BICS) sector, loan type, loan signing date, loan maturity, use of proceeds, loan tranche size, call option, covenant-lite agreement, index floor, loan issue status, loan payment rank, coupon, loan base index at close, loan spread at close, initial Fitch rating, initial Moody's rating, initial S&P rating, Fitch rating as of 31 December 2019, Moody's rating as of 31 December 2019, and S&P rating as of 31 December 2019.

By *country of domicile* we mean the country where the borrower has its registered office, which does not always coincide with the country where the company mainly operates. By comparing data related to the *country of domicile* with those related to the *loan tranche size*, it is possible to obtain the size of the European leveraged loan market for each country, as shown in Table 1 (last column).

Loan rank simply refers to the order of repayment in case of a default. *Use of proceeds* means the purpose for which the main operation was born, which can be summarized as acquisition, refinancing, general corporate purposes or other secondary purposes. Table 1 also crosses the data on loan size for *country of domicile* and *use of proceeds*.

By comparing the size of this market in each country for each type of operation, it is possible to understand whether companies in a country are investing more in acquisitions or in refinancing debt. For instance, in Table 1, for France and The Netherlands, the purpose of acquisition/merger is prevalent. The use of leverage loans has an important role in supporting the growth process of firms. Given the importance of firm size and the related economies of scale in the competitive landscape, this could be food for thought for countries at the end of the ranking. These numbers also confirm that large companies have easier access to finance (Ferrando et al., 2022) also thanks to multiple sources of lending, including the leveraged loan market.

The *loan tranche size* measures the size of the specific tranche of the loan upon issue, which can obviously differ from the outstanding amount recorded subsequently. It is common for larger tranches, reaching up to 1 billion, to be granted to borrowers with higher creditworthiness, whereas tranches of up to 300 million are granted to lower-rated or unrated borrowers (see Figure B.1 where the average amount for different ratings is plotted against year).

Table 1
Leveraged loan market size in mil. by *use of proceeds* and *country of domicile* as of 31 December 2019.

Domicile	Acquisition	General purposes	Other	Refinance	Tot.
FR	16,606.32	229.74		13,112.00	29,948.06
NL	15,000.17	197.26		12,752.85	27,950.28
GB	13,545.66	389.06	975.16	18,067.41	32,977.29
LU	12,298.79	585.00	1,680.33	16,153.95	30,718.07
US	10,825.80	555.00	820.00	13,183.15	25,383.95
DE	6,328.94		705.00	14,427.66	21,461.60
ES	4,505.78	85.00		1,640.70	6,231.48
SE	3,019.00			4,933.00	7,952.00
DK	2,902.00			1,900.00	4,802.00
IE	1,712.76			287.30	2,000.06
JE	1,516.42				1,516.42
AT	980.00				980.00
CA	850.00				850.00
CH	543.00				543.00
BE	417.00			550.00	967.00
MT	275.00				275.00
IT	250.00			355.00	605.00
FI			1,700.00	760.00	2,460.00
GI				1,125.00	1,125.00
NO				1,245.00	1,245.00
Total	91,576.64	2,041.06	5,880.49	100,493.02	199,991.21

Notes: This Table provides statistics for the leveraged loan market size by use of proceeds and country of domicile. The values are in millions of euros, and are in descending order according to the "Acquisition" column. These statistics have been computed as of 31 December 2019.

The *call option* is a binary variable equals to 1 for a loan agreement that allows the lender to request repayment at any time, and 0 otherwise.

The *loan coupon* (which is floating) specifies the interest rate for the loan, which can be obtained through the sum of the *loan index floor* and the *loan spread*. Usually, higher spreads correspond to lower ratings and vice versa (see Figure B.2 where the ratio of Libor/Euribor spread for different ratings is plotted against year). The binary variable *covenant-lite* takes the value 1 if there is a covenant-lite agreement, and 0 if there is a traditional financial covenant. In our sample, about 80.81% of the loans are covenant-lite, confirming that this loan type has become the market standard. Of the traditional loans, 83.34% are non-defaulting, a share that rises to 98.20% for the covenant-lite loans. In our data, the prevalence of covenant-lite for loans domiciled in the US emerges already in 2014, confirming that the European market is gradually adapting to the market standard adopted in the US (see Figure B.3 for the trend of covenant-lite loans for different countries from 2013 to 2019). By investigating the trend in the prevalence of covenant-lite loans for different S&P credit ratings, we note a slower increase for non-rated loans. This, too, highlights a tendency to grant more covenant-lite agreements for loans with public information (see Figure B.4, which shows a lowest percentage of covenant-lite loans for not rated loans).

Data were integrated with annual balance sheet information from Orbis (Bureau van Dijk). In particular, the following variables were extracted for the period 2013–2019: EBITDA, EBIT, ROA, ROE, ROC, profit margin, gross margin, current ratio (CR), total debt (TD), total assets, current liabilities, cash flow, net income, debt on EBITDA and debt on assets ratios. The value of these indicators both at 31 December 2019 and at the time the loan began is used in our modeling strategy. In particular, for each loan the information *loan signing date* was extracted, and the balance sheet indicators on 31 December of the previous year are used to understand their role in the decision to grant or reject a covenant-lite agreement.

A bivariate analysis of the average for some continuous variables crossed with the different levels of other categorical variables shows important preliminary differences (see Table B.1). For example, covenant-lite loans tend to have a better financial profile, through higher EBITDA, ROA and CR, and lower Total Debt. Similarly, non-defaulted loans obviously show better financial characteristics. Finally, focusing on the other categorical variables, it is possible to note differences based on the BICS Sector, Country of Domicile and Use of Proceeds.

4. Methods

In this section we illustrate the procedure and methodologies used to gauge how much the total effect of the balance sheet indicators (e.g. EBITDA and ROA) on the probability of default is due to the mediating effect of the covenant-lite agreement. Beginning in the 1980s, the use of mediation analysis increased also among social scientists, in particular in psychological sciences (Judd and Kenny, 1981; Baron and Kenny, 1986; MacKinnon et al., 2007), and recently it has been applied to medicine and biostatistics (Bind et al., 2016). However, it has not yet been used in the financial world.

In its simplest form, we assume a data generating mechanism where the variable X, in this context called the treatment variable, is a potential cause of the mediator M, and where M and X together are potential causes of Y. These assumptions are depicted in Fig. 1, via a directed acyclic graph (Pearl, 2009). The purpose of the mediation analysis is to quantify the effect of an external intervention to set, possibly contrary to fact, X at two possible values: a value $x^\star$, usually considered a reference value, and a second value x, with $x > x^\star$. The aim of mediation is to decompose the total effect on Y of this intervention into a direct and an indirect effect, the latter mediated by M. Let $Y(x)$ and $M(x)$ equal the value that Y and M would take if X is externally set to x. Let $Y(x, m)$ equal the value that Y would take if x is set to x and M is set to m. More details in Appendix A.2.

We then define the *total effect*, which is the difference between the expected value of the potential outcomes under the two different interventions:

$$TE_{x,x^\star} = E[Y(x) - Y(x^\star)] \tag{1}$$

This effect is called total because it is marginal with respect to M. It can then be decomposed into two effects: a *pure natural direct effect* (PNDE) and a *total natural indirect effect* (TNIE).

The *pure natural direct effect* describes the expected difference between potential outcomes by moving X from $x^\star$ to x, keeping the mediator at the value it would have if X is kept at the level $x^\star$:

$$PNDE_{x,x^\star} = E[Y(x, M(x^\star)) - Y(x^\star, M(x^\star))] \tag{2}$$

The *total natural indirect effect* describes the expected difference between potential outcomes if X is kept constant to x but the mediator varies from the value it would take under x to the value it would take under x^*:

$$TNIE_{x,x^\star} = E[Y(x, M(x)) - Y(x, M(x^\star))] \tag{3}$$

Note that, as expected, $TE_{x,x^\star} = PNDE_{x,x^\star} + TNIE_{x,x^\star}$. These effects provide, therefore, a decomposition of the total effect. In addition, one should consider the *controlled direct effect*, i.e. the expected difference between potential outcomes by moving X from $x^\star$ to x while holding the mediator constant at a specific level m:

$$CDE_{x,x^\star} = E[Y(x, m) - Y(x^\star, m)] \tag{4}$$

The following assumptions establish a link between the counterfactual variables and the observable ones.

- Consistency assumption: when the population is exposed to the treatment $X = x$, then the potential outcome $Y(x)$ equals the observed outcome Y for that population, i.e. $P(Y(x) = y \mid X = x) = P(Y = y \mid X = x)$;
- Composition assumption: $P(Y(x, M(x)) = y) = P(Y(x) = y)$.

For comments on these assumptions, see VanderWeele and Vansteelandt (2009) and VanderWeele (2009).

To identify the causal effects, we need the following conditions (VanderWeele, 2015, Appendix A.2):

$$Y(x, m) \perp\!\!\!\perp X \ \forall\ x \text{ and } m \tag{5a}$$

$$Y(x, m) \perp\!\!\!\perp M \mid X \ \forall\ x \text{ and } m \tag{5b}$$

$$M(x) \perp\!\!\!\perp X \ \forall\ x \tag{5c}$$

$$Y(x, m) \perp\!\!\!\perp M(x^\star) \ \forall\ x,\ x^\star \text{ and } m \tag{5d}$$

where $Z \perp\!\!\!\perp W \mid U$ is used to denote that the random variables Z and W are conditionally independent after conditioning on U (Dawid, 1979). In other words, these identifying conditions imply that the unobserved factors influencing each potential outcome are independent. Sometimes the above assumptions are satisfied only after conditioning on a set of observed confounders C. A discussion on the use of counterfactuals in causal analysis can be found in Robins and Greenland (1992), Dawid (2000), Pearl (2000) and Rubin (2000). See Pearl (2009), Ch. 7, or Pearl (2014) for an explanation that links the above assumptions to structural equation models.

In this context, the mediator is M, a dummy variable equal to 1 if the covenant-lite agreement is present, and the outcome is Y, also a dummy variable equal to 1 in case of default. As a consequence, the mediator and outcome equations are logistic regression models, where the relationship between total effect and direct and indirect effects is additive on the log-odds scale. For binary outcomes, VanderWeele and Vansteelandt (2010) and Valeri and VanderWeele (2013) define the causal effects on the odds-ratios scale, in a multiplicative fashion. However, their work hinges on the assumption that the outcome is rare. To overcome this and other limitations, Doretti et al. (2021) provide a parametric expression for natural direct and indirect effects; see also Stanghellini and Kateri (2022) for the ordinal response case. In this paper we use their parametric decomposition of the total causal effect.

5. Results

We investigated the structure of the missing data and found no evidence of any informative relationships. Because of the imbalance in the binary response variable *default*, in this work we use a Synthetic Minority Over-sampling Technique (SMOTE); see Chawla et al. (2002) amnd Ogundimu (2019). The SMOTE algorithm rebalances the dataset by introducing synthetic examples of the minority class through a smoothing method to avoid overfitting. We then fit two logistic regression models to the augmented data (Crook et al., 2007; Lando, 2009). This allows us to balance the accuracy, efficiency and interpretability of the results obtained (Crone and Finlay, 2012).

The two initial logistic models are fitted: the first one with the covenant-lite indicator M as a response against all possible covariates, i.e. Loan Size, Loan Rank, initial EBITDA (measured at the loan starting date), ROA (measured at the loan starting date),

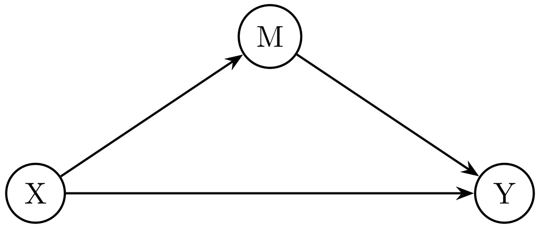


Fig. 1. The data generating mechanism for the mediation scheme.
Notes: In this graphical representation, the mediation scheme for decomposing the effect of X on Y into direct ($X \to Y$) and indirect ($X \to M \to Y$) pathways through M is depicted.

Table 2
Results from the fitted logistic models for the mediator (H1).

	Dependent variable:			
	$covenant - lite$			
	(1)	(2)	(3)	(4)
ROA_{init}	1.027***	0.817***	0.762***	1.480***
	(0.291)	(0.184)	(0.185)	(0.316)
$LoanSize$	0.695***	0.511***	0.792***	1.334***
	(0.247)	(0.164)	(0.211)	(0.344)
Intercept	1.747***	−17.750	1.318***	−13.070
	(0.246)	(2,465.326)	(0.315)	(2,465.326)
Industry fixed effects	Yes	No	Yes	Yes
Year fixed effects	No	No	Yes	Yes
Credit rating fixed effects	No	No	No	Yes
Country fixed effects	No	Yes	No	Yes
Use of proceeds fixed effects	No	No	No	Yes
Log Likelihood	−106.829	−241.077	−232.200	−155.553
Akaike Inf. Crit.	223.659	518.153	488.400	379.105

Notes: This table presents the results obtained from the estimated logistic model for the mediator as dependent variable. For illustrative clarity, Model (1) is the model selected by minimizing the AIC criterion, while Model (2), Model (3) and Model (4) consider different fixed effects as a robustness check. The statistical significance of the results is denoted in the following manner: *p<0.1; **p<0.05; ***p<0.01, where p is the p-value.

initial Total Debt (measured at the loan starting date), controlling for Industry, Year, Initial Moody's rating, Use of Proceeds and Country of Domicile; the second, with the default indicator Y as a response against M and the previous set of covariates with also Loan Spread (measured at the loan starting date) and EBITDA, ROA, Total Debt and Current Ratio measured as of 31 December 2019. Some covariates act as possible confounders, i.e. the covariates C that are necessary to make assumptions (5a)–(5d) acceptable. These are structural covariates such as Loan Size, Loan Rank, BICS sector, Use of Proceeds, Country of Domicile, Loan Spread and Initial Moody's rating. The study of the total causal effect and of its decomposition is performed for the financial variables measured at the loan starting date. Table B.2 of the Appendix lists all covariates included in both models, together with their role in this analysis.

The final logistic models are obtained through stepwise selection (Venables and Ripley, 2013) to minimize the AIC (Akaike Information Criterion) (Akaike, 1998). The AIC model-fitting criterion is used as a performance indicator to avoid overfitting by adding variables to a model. This is achieved by using a penalty term as the number of variables in the model increases.

Table 2 presents the results of the model selection procedure and the estimated parameters of the first logistic regression, with the covenant-lite agreement as a response. Loan size in this model shows a significant positive effect on the probability of obtaining the agreement, which could be due to the greater bargaining power of companies having larger amounts financed with a leveraged loan. Finally, ROA measured at the starting date of the loan (ROA_{init}) has a positive effect on the probability of obtaining a covenant-lite. This demonstrates that the decision to grant the covenant-lite agreement is given on the basis of the high profitability, as our Hypothesis 1 postulates.

Table 3 presents the results of the model selection procedure and the estimated parameters of the second logistic model, with the default event as a response. The significant variables include the covenant-lite agreement with a negative effect on the probability of default. Since this effect holds for all other covariates being equal, it is probably due to the covenant-lite's greater flexibility and lower financial burden compared with a traditional agreement (Hypothesis 2).

Loan Size with a negative effect highlights the greater probability of default for borrowers who use leveraged loans for smaller amounts. For the financial variables, we note that the ROA_{init}, the EBITDA and the Current Ratio both measured as of December 2019 ($EBITDA_{19}$ and CR_{19}), have a negative effect on the probability of default, as opposed to Total Debt measured on the same date (TD_{19}), which shows a positive effect.

Note that the initial Moody's rating in model (4) (forth column in Table 3) does not change the signs of the above coefficients. However, the model minimizing the AIC does not include this as a control variable.

Table 3
Results from the fitted logistic models for the outcome (H2).

	Dependent variable:			
	Default			
	(1)	(2)	(3)	(4)
$covenant-lite$	−2.088***	−2.644***	−2.953***	−2.742***
	(0.703)	(0.661)	(0.649)	(0.768)
ROA_{init}	−2.589***	−4.120***	−5.271***	−7.285***
	(0.720)	(0.966)	(0.981)	(1.496)
$LoanSize$	−2.801***	−4.203***	−4.523***	−7.759***
	(0.705)	(1.114)	(0.867)	(1.566)
TD_{19}	1.783***	1.997***	2.275***	3.311***
	(0.473)	(0.449)	(0.416)	(0.733)
$EBITDA_{19}$	−1.168***	−0.052	−0.928***	−1.829***
	(0.302)	(0.227)	(0.207)	(0.491)
CR_{19}	−3.725**	−5.701***	−6.391***	−9.235***
	(1.478)	(1.325)	(1.457)	(2.838)
Intercept	−5.592***	−24.405	−5.515***	−8.971***
	(1.336)	(11,048.820)	(1.206)	(2.736)
Industry fixed effects	Yes	No	Yes	Yes
Year fixed effects	No	No	Yes	Yes
Credit rating fixed effects	No	No	No	Yes
Country fixed effects	No	Yes	No	No
Use of proceeds fixed effects	No	No	No	Yes
Log Likelihood	−36.946	−60.255	−63.015	−44.180
Akaike Inf. Crit.	91.893	164.510	158.029	134.360

Notes: This table presents the results obtained from the estimated logistic model for the default event as dependent variable. For illustrative clarity, Model (1) is the model selected by minimizing the AIC criterion, while Model (2), Model (3) and Model (4) consider different fixed effects as a robustness check. The statistical significance of the results is denoted in the following manner: *p<0.1; **p<0.05; ***p<0.01, where p is the p-value.

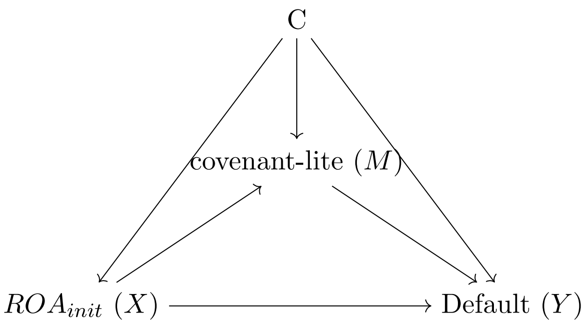


Fig. 2. Causal mediation setting for Initial ROA as exposure.
Notes: This Figure represents the mediation setting by considering the Initial ROA as exposure X, the covenant-lite dummy variable as mediator M, and the default event as outcome Y. We define with C all possible confounders included in the logistic models.

Note that in Tables 2 and 3, the initial ROA is statistically significant in both regressions. It therefore constitutes a natural candidate for the decomposition of the total effect into a direct and an indirect effect, the latter due to the covenant-lite agreement M. The causal mediation setting that we want to assess is therefore the one shown in Fig. 2, including both the direct pathway $X \rightarrow Y$ and the indirect pathway $X \rightarrow M \rightarrow Y$.

The effect related to the pathway $X \rightarrow M$ is positive, the effect related to $M \rightarrow Y$ is negative and the effect related to $X \rightarrow Y$ is negative. Overall, we therefore have both a negative direct effect and also a negative indirect one, as the initial ROA increases the probability of obtaining a covenant-lite, which in turn decreases the probability of defaulting. In addition, the coefficients related to the pathway $X \rightarrow M \rightarrow Y$ are not so small compared with those of pathway $X \rightarrow Y$, suggesting that the indirect effect may play a role.

We then use the parametric expression decomposition as provided by Doretti et al. (2021). In Table 4 we report the estimated total, direct and indirect effects on the log-odds scale, if $x^{\star}$ is equal to the average amount of the initial ROA in the sample (3.77) and $x = x^{\star} + 1$, i.e. when the ROA is 1 point higher than the observed average value. The effects refer to loans with average Total Debt, average EBITDA and average Current Ratio and different levels of the BICS Sector and Loan Size covariates. The table also reports standard errors and 95% confidence intervals, built using the delta method (Oehlert, 1992). All 95% confidence intervals for the direct, indirect and total effects are quite far from 0, showing that all effects are significant.

Table 4
Estimates, standard errors (SEs), 95% confidence intervals (CIs) and *p*-values of the causal log-odds ratios for the mediation scheme of Fig. 2.

	Est.	SE	95%	CI	p value	Est.	SE	95%	CI	p-value
	S=Comm., L=509 mil.					*S=Comm., L=609 mil.*				
$\log OR_{PNDE}$	−0.208	0.065	−0.336	−0.080	0.001	−0.216	0.066	−0.345	−0.087	0.001
$\log OR_{TNIE}$	−0.033	0.014	−0.061	−0.005	0.021	−0.034	0.014	−0.062	−0.006	0.017
$\log OR_{TE}$	−0.241	0.064	−0.367	−0.116	0.000	−0.250	0.064	−0.376	−0.124	0.000
	S=Techn., L=509 mil.					*S=Techn., L=609 mil.*				
$\log OR_{PNDE}$	−0.195	0.061	−0.316	−0.075	0.001	−0.205	0.067	−0.338	−0.073	0.002
$\log OR_{TNIE}$	−0.035	0.017	−0.068	−0.002	0.039	−0.036	0.016	−0.066	−0.005	0.021
$\log OR_{TE}$	−0.230	0.061	−0.350	−0.111	0.000	−0.241	0.066	−0.371	−0.111	0.000
	S=Other, L=509 mil.					*S=Other., L=609 mil.*				
$\log OR_{PNDE}$	−0.227	0.063	−0.351	−0.103	0.000	−0.227	0.063	−0.351	−0.103	0.000
$\log OR_{TNIE}$	−0.039	0.018	−0.075	−0.003	0.035	−0.032	0.013	−0.058	−0.006	0.017
$\log OR_{TE}$	−0.266	0.063	−0.389	−0.143	0.000	−0.259	0.062	−0.381	−0.137	0.000

Notes: This table presents estimates, standard errors (SEs), 95% confidence intervals (CIs) and *p*-values of the causal effects, where $\log OR_{PNDE}$ is the direct effect, $\log OR_{TNIE}$ is the indirect effect, and $\log OR_{TE}$ is the total effect. The causal effects are reported for six different settings, by controlling for sectors (S) and Loan size (L).

Table 4 shows that results are stable across the different covariate patterns. The estimated $\log OR_{PNDE}$ lies between −0.227 and −0.195, and the estimated $\log OR_{TNIE}$ lies between −0.033 and −0.039. Regarding the $\log OR_{TE}$, the estimates lie between −0.230 and −0.266 and represent the total marginal effect on the log-odds ratio of the default due to an increase in the initial value of the ROA from $x^\star$ to x. As expected, this increase has a negative impact on the probability of default.

In this setting, the $\log OR_{PNDE}$ expresses how much the log-odds ratio of the default event decreases if the ROA goes from $x^\star$ to x but the decision to grant the covenant-lite is taken as if the ROA were at $x^\star$. We could hypothesize a situation in which the lender decides to grant the covenant-lite as if unaware of an increase in the initial value of ROA, therefore behaving as if it were constant at $x^\star$. Thus, considering the negative and similar effects for all six cases, an increase in ROA decreases the log-odds ratio of default. The $\log OR_{TNIE}$ expresses the opposite case: i.e. the effect on the probability of default if the lender is informed that the initial ROA has increased from $x^\star$ to x but in fact the initial value of the ROA value is fixed at x. This is therefore the effect that passes through the decision to grant the covenant-lite, which also in this case is negative and similar for all six patterns and shows a decrease in the log-odds ratio of the default as the lenders review the judgment on the granting of the covenant-lite on the basis of a higher profitability of the financed company. Note that the total natural indirect effect makes a smaller contribution to the total effect than the direct effect does. However, since it is significantly different from zero, it cannot be neglected.

In general, these analyses support the validity of our conjectures about the causal effects of the covenant-lite agreement. A higher initial ROA decreases the probability of default not only directly but also indirectly through the granting of the covenant-lite. The direct effect reduces it more, but the indirect effect remains a significant effect to consider. As in any empirical study, it is not easy to guarantee with certainty the absence of confounders in the model; therefore, the results must be interpreted with caution. Indeed, there could be some unobserved confounders of the relationship between the mediator variable covenant-lite and the probability of default, such as the managerial skills of a company's board. We address this issue in the next subsection.

5.1. Endogeneity check for the effect of the covenant-lite agreement on the probability of default

The decreasing effect of the covenant-lite agreement on the probability of default is not completely in line with either the widespread concern by financial authorities (Federal Reserve, 2013; European Central Bank, 2017, 2018) and previous research on the expectation of increased probability of default for the covenant-lite agreement (Davydenko et al., 2020; Demerjian et al., 2020), but is partially in line with the results of another strand of literature (do Rosário Correia, 2008; Cao and Xia, 2021). Based on our results, we notice that the negative sign of the coefficient of the mediator in the second logistic regression (Table 3) should be interpreted as a decreasing effect of the agreement, also after taking into account the effects of the balance sheet indicators and the background variables. One possible alternative explanation is that the decision to grant the agreement is driven not only by the observed covariates included in the first logistic model (Table 2) but also by unobserved factors that also influence the probability of default. In other words, lenders possess additional information, not reflected in the data, that allows them to reduce information asymmetries by screening and granting the covenant-lite agreement only for the best-performing loans.

This additional information may be represented by a latent variable, that we denote by U, that induces the endogeneity of the decision to grant the covenant-lite agreement. In Fig. 3 this postulated unobserved factor is added, in order to represent the possible endogenous nature of M. Double line is to represent the fact that U is not observed.

In this paragraph we perform a sensitivity analysis as endogeneity check, with the aim of gaining some further insights on this point. Endogeneity check allows us to explore how strong the effect of unobserved factors should be in order to revert the sign of the estimated effect; see e.g. VanderWeele (2015), Ch. 3. We postulate that loans can be partitioned into two groups, i.e. that U is a binary random variable taking value $U = 1$ in best loans, and $U = 0$ otherwise. U could be a binary variable related to the quality of the governance of the borrowers, taking the value 1 for high-quality governance. In order to use the derivations proposed

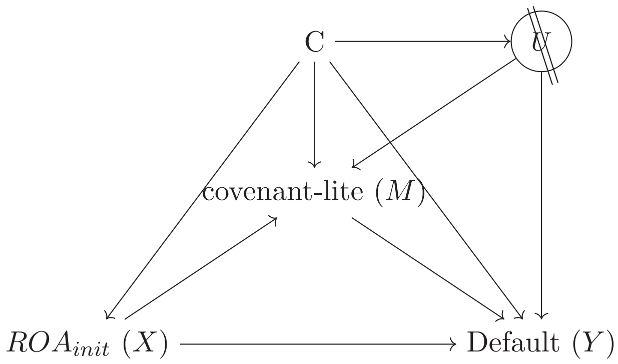


Fig. 3. Causal mediation setting with an unobserved confounder U.
Notes: This Figure represents the mediation setting by considering the Initial ROA as exposure X, the covenant-lite dummy variable as mediator M, and the default event as outcome Y. We define with C all possible confounders we consider in the logistic models, and with U the unobserved factor that could influence the probability of default.

by VanderWeele (2015), paragraph 3.1.4, we transformed our estimates of the effect of covenant-lite M on the probability of default Y at a particular value $C = c$ of the covariates, into the risk ratio scale, i.e.:

$$RR_{Y|M,c} = \frac{P(Y = 1 \mid M = 1, c)}{P(Y = 1 \mid M = 0, c)} \tag{6}$$

Let γ be the effect of the unobserved variable U on Y, conditional on $M = m$ and $C = c$ on the risk ratio scale, i.e.:

$$\gamma = \frac{P(Y = 1 \mid m, c, U = 1)}{P(Y = 1 \mid m, c, U = 0)} \tag{7}$$

The underlying assumption is that the effect of U on the relative risk of default is the same in the two groups ($M = 0$ and $M = 1$). We then define the bias factor of the risk ratio comparing $M = 1$ and $M = 0$, i.e. whether the covenant-lite agreement is present or not:

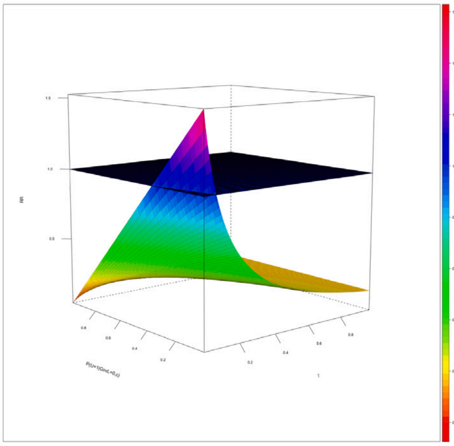
$$Bias = \frac{1 + (\gamma - 1)P(U = 1 \mid M = 1, c)}{1 + (\gamma - 1)P(U = 1 \mid M = 0, c)} \tag{8}$$

Dividing the risk ratio by the bias, we obtain the new $RR_{Y|M,c,U}$, which is the relative risk of default, after conditioning on U: values greater than 1 will now indicate an increasing effect of the covenant-lite agreement on the probability of default in both groups of loans (those with good governance and those without), and values lower than 1 will denote a negative association. Our goal is to see for which values of the components of the $Bias$ (namely, γ, $P(U = 1 \mid M = 1, c)$ and $P(U = 1 \mid M = 0, c)$) the value of the relative risk becomes greater than 1.

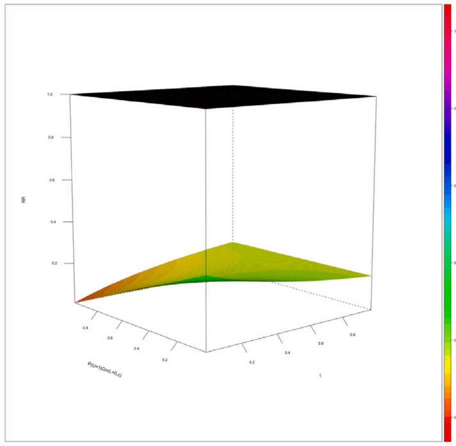
To begin the derivations, we set c as in the first scenario of Table 4. In this case, the $RR_{Y|M,c}$ is equal to 0.17, meaning that the presence of a covenant-lite agreement reduces the risk of default by more than 5 times. To obtain the $Bias$, considering that U is not observed, it is necessary to make some assumptions on the values of γ, $P(U = 1 \mid M = 1, c)$ and $P(U = 1 \mid M = 0, c)$. To do so, we postulate different values for $P(U = 1 \mid M = 1, c)$ and let γ and $P(U = 1 \mid M = 0, c)$ vary between 0 and 1. In Fig. 4(a) we impose $P(U = 1 \mid M = 1, c) = 0.9$ and plot the $RR_{Y|M,c,U}$ for all possible values of γ and $P(U = 1 \mid M = 0, c)$. Note that $P(U = 1 \mid M = 1, c) = 0.9$ implies that 90% of the loans with a covenant-lite agreement belong to the group with $U = 1$. The figure shows that only when γ and $P(U = 1 \mid M = 0, c)$ are close to zero does the relative risk becomes higher than 1: in particular for a $P(U = 1 \mid M = 0, c)$ of less than 0.4 and a γ lower than 0.1. Note that a $P(U = 1 \mid M = 0, c)$ of less than 0.4 implies that in the group of loans with $M = 0$, the loans falling into the category $U = 1$ are less than 40%. Similarly, a γ close to zero implies that the probability of default in the group of loans with $U = 1$ is very small compared with the probability in the group of loans with $U = 0$. In Fig. 4(b) the same plot is produced for $P(U = 1 \mid M = 1, c) = 0.5$, somehow a less extreme situation that implies that 50% of the loans with a covenant-lite agreement belong to the group with $U = 1$. In this second scenario the relative risk never exceeds 1. Finally, in Fig. 4(c) the plot is made for the lowest value of $P(U = 1 \mid M = 1, c)$ for which the relative risk never exceeds 1, which in this case corresponds to 0.84. Similar conclusions apply when we consider the other five scenarios of Table 4, as the $RR_{Y|M,c}$ is never greater than 0.22. These analyses lead us to conclude that under the above assumptions of one binary latent variable U capturing all unobserved information with no interactions between M and U, only in rather extreme situations is a latent variable U able to revert the sign of the effect of the covenant-lite agreement on the probability of default.

6. Discussion and conclusions

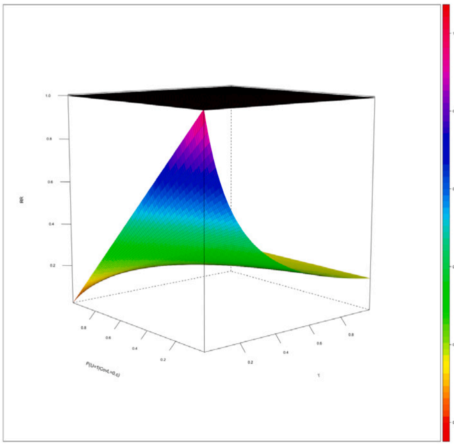
Leveraged loans are syndicated loans granted to large companies having non-investment-grade ratings and are mainly used for debt refinancing, acquisitions or mergers. These alternative debt instruments, as we have highlighted, are essential in supporting



(a) $P(U = 1 \mid CovLite = 1, c) = 0.9$



(b) $P(U = 1 \mid CovLite = 1, c) = 0.50$



(c) $P(U = 1 \mid CovLite = 1, c) = 0.84$

Fig. 4. Endogeneity check for the effect of the covenant-lite agreement on the probability of default.
Notes: In this Figure, the black surface represents the value 1 for the relative risk, i.e. the value above which there is a sign reversion for the effect of the covenant-lite on the probability of default. In Figure (a) we assume that $P(U = 1 \mid CovLite = 1, c) = 0.9$, i.e. that in the group of loans with $M = 1$, the loans falling into the category $U = 1$ are the 90%. Similarly, we also assume $P(U = 1 \mid CovLite = 1, c) = 0.5$ and $P(U = 1 \mid CovLite = 1, c) = 0.84$ in Figs. 4 (b) and 4 (c). Only in Fig. 4 (a), a quite extreme situation, a sign reversion is possible. This happens when (a) $P(U = 1 \mid CovLite = 0, c)$ is less than 0.4, i.e. in the group of loans with $M = 0$, the loans falling in the category $U = 1$ are less than 40%, and (b) γ is less than 0.1, i.e. the probability of default of the loans in group $U = 1$ is very small when compared with the group $U = 0$, keeping constant all other variables. Finally, notice that if $P(U = 1 \mid CovLite = 1, c) < 0.84$ no sign reversion is possible.

the growth process of companies, for both the restructuring and external growth phases; consequently, they are crucial also in terms of competitiveness between countries.

In this study we analyze the role of the covenant-lite agreement that is granted by lenders during the underwriting process. For this purpose, we use mediation analysis to explore whether a covenant-lite agreement can serve as a mediator variable. This approach allows us to confirm that lenders do not actually grant the covenant-lite agreement to borrowers with a lower profitability, as the probability of receiving the agreement decreases for loans with a fragile profile, according to their balance sheet indicators and other background variables. Furthermore, our analyses show that after taking into account the indicators and the background variables, the covenant-lite agreement reduces the probability of default. A possible explanation for the positive impact of the covenant-lite agreement is that it brings companies greater flexibility and lessens their financial burden. The use of mediation analysis also allows us to disentangle the direct effect from the total effect of initial ROA on the probability of default, i.e. the effect not due to the lender's decision to grant a covenant-lite agreement, and the indirect one, i.e. the one transmitted through the decision to grant a covenant-lite agreement. The significance of the direct and indirect effects leads us to conclude that a higher initial ROA not only directly decreases the probability of default but also increases the probability of obtaining a covenant-lite, which in turn decreases the probability of defaulting. To assess whether the effect of the covenant-lite agreement is induced by some unobserved factors, we performed a endogeneity check that showed that only in rather extreme scenarios could the effect of the agreement on the probability of default be reverted.

Only the correct identification of default risk allows us to effectively monitor those lenders who have a higher concentration of risky leveraged loans. For this purpose, this first use of mediation analysis to identify the probability of default lays the foundation for an alternative to previous approaches used in this field. A limitation of this study could be in the assumptions underlying the endogeneity check, which postulates one latent binary factor U capturing all unmeasured information. In fact, due diligence in this type of transaction is based not only on available financial information but also on qualitative information that banks possess and that they are able to exploit thanks to managerial skills. However, we believe our research could point to some interesting evidence that should be verified in future studies.

CRediT authorship contribution statement

G. De Novellis: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Investigation, Formal analysis, Data curation, Conceptualization. **P. Musile Tanzi:** Writing – review & editing, Writing – original draft, Supervision, Project administration. **E. Stanghellini:** Writing – review & editing, Writing – original draft, Supervision, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Methodological appendix

A.1. Background: leveraged loan and financial covenants definition

There is no univocal definition of a leveraged loan, the meaning of which often varies greatly when comparing the supervisory authorities criteria with the main data-providers approach. In general, the European Banking Authority (2020) reports the following characteristics:

- debt-to-EBITDA ratio of four times (or higher);
- credit rating below BBB, i.e. non-investment-grade;
- loan purpose to finance an acquisition/merger or to refinance the borrower;
- private equity firm acting as sponsor of the operation;
- high initial spread at issuance.

S&P Global Market Intelligence (2022) defines a loan as "leveraged" if it is rated BB+ or lower or if it is not rated (or rated BBB- or higher) but has a spread over LIBOR/EURIBOR of 125bps or higher and is secured by a first or second lien. Leveraged loans are usually provided through a syndication process, via an arranger bank that acts to promote the syndication of the loan where lenders contract with a borrower, based on a common document that defines the obligations to be fulfilled by the syndicate members (Lim et al., 2014).

The syndication process either begins with a borrower's request to a lender through a mandate or is initiated by a sponsor (usually a private equity house) for making leveraged transactions (acquisitions). Afterwards, the sponsor appoints other financial institutions to act as arrangers of the leveraged transaction (Sufi, 2007). The lender (or a group of lenders) who acts as arranger of the syndication composes the syndicate, defining conditions and purposes of the operation (Lim et al., 2014). The arrangers (or co-arrangers) provide an initial agreement on the loan's characteristics and then find other lenders to participate in the loan. Typically, one of the lenders assumes the role of agent, which is considered the point of contact for the syndicate, monitors the compliance of the agreement, records all the notices coming from the lenders and acts as payment agent for the operations (interests, repayments and other required payments). Because loans are usually secured, a lender from the syndicate acts as security agent to hold the security used as collateral.

The financial covenants typically included in leveraged loan transactions are as follows:

- leverage covenant: this indicates the level of debt against other accounts such as a cash flow statement, income statement and balance sheet. Those most commonly used by market analysts and investors are Debt-to-EBITDA ratio, Debt-to-Assets ratio and Debt-to-Equity ratio;
- current-ratio covenant: this requires the borrower to maintain a minimum ratio of current assets to current liabilities;
- coverage covenant: this compares the cash flow generated by the borrower with the aggregate of its debt, requiring the borrower to maintain a certain level of cash flow or earnings relative to expenses and debt;
- tangible-net-worth (TNW) covenant: this specifies a minimum level of TNW, often compared with net income;
- maximum-capital-expenditures covenant: this requires the borrower to limit capital expenditures (for purchases of property etc.) to a fixed amount.

A.2. Methodology and notation

We introduce the notion of total, direct and indirect effects by assuming that both M and Y are continuous random variables. The interpretation does not change if, as in our case, Y and M are binary random variables. Only the mathematical formulation of the effects changes.

In the context of the linear model, the decomposition of the total effects hinges on the work of Cochran (1938). Cochran's formula decomposes the marginal regression coefficient of Y on X into the sum of products of pathway-specific regression parameters, starting from the following two equations:

$$Y = \beta_0 + \beta_X X + \beta_M M + \epsilon_Y \tag{9a}$$

$$M = \gamma_0 + \gamma_X X + \epsilon_M \tag{9b}$$

where linear least square assumptions are satisfied for each equation and ϵ_Y and ϵ_m are independent. By substituting Eq. (9b) in Eq. (9a), we obtain

$$Y = \beta_0 + \beta_X X + \beta_M(\gamma_0 + \gamma_X X + \epsilon_m) + \epsilon_Y \tag{10}$$

Therefore, by marginalizing on M, we have

$$Y = \beta_0^* + \beta_X^* X + \eta_Y \tag{11}$$

where $\eta_y = \beta_M \epsilon_M + \epsilon_Y$, and

$$\beta_0^* = \beta_0 + \beta_M \gamma_0 \tag{12a}$$

$$\beta_X^* = \beta_X + \gamma_X \beta_M \tag{12b}$$

It then follows that under the assumptions above,

- $TE_{x,x^\star} = \beta_X^*(x - x^\star)$;
- $CDE_{x,x^\star} = \beta_X(x - x^\star)$;
- $PNDE_{x,x^\star} = \beta_X(x - x^\star)$;
- $TNIE_{x,x^\star} = \gamma_X \beta_M(x - x^\star)$.

Note that the pure natural direct effect and the controlled direct effect coincide and that both depend only on the difference $(x - x^\star)$. Note, further, that $\beta_X^* - \beta_X = \gamma_X \beta_M$, leading to two possible ways to assess the indirect effect, one that makes use of the product of the coefficients $\gamma_X \beta_M$, and one that makes use of the difference between the $TE_{x,x^\star}$ and the $PNDE_{x,x^\star}$. These results are, however, limited to the simple linear models and do not hold in general.

Appendix B. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.ribaf.2024.102377.

References

Achleitner, A.-K., Braun, R., Hinterramskogler, B., Tappeiner, F., 2012. Structure and determinants of financial covenants in leveraged buyouts. Rev. Finance 16 (3), 647–684.
Akaike, H., 1998. Information theory and an extension of the maximum likelihood principle. In: Selected Papers of Hirotugu Akaike. Springer, pp. 199–213.
Allen, F., Santomero, A.M., 1997. The theory of financial intermediation. J. Bank. Finance 21 (11–12), 1461–1485.
Baron, R.M., Kenny, D.A., 1986. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. J. Personal. Soc. Psychol. 51 (6), 1173.
Becker, B., Ivashina, V., 2016. Covenant-light contracts and creditor coordination. Riksbank Research Paper Series, (149), pp. 17–1.
Berlin, M., Nini, G., Edison, G.Y., 2020. Concentration of control rights in leveraged loan syndicates. J. Financ. Econ. 137 (1), 249–271.
Billett, M.T., Elkamhi, R., Popov, L., Pungaliya, R.S., 2016. Bank skin in the game and loan contract design: Evidence from covenant-lite loans. J. Financ. Quant. Anal. 51 (3), 839–873.
Bind, M.-A., Vanderweele, T., Coull, B., Schwartz, J., 2016. Causal mediation analysis for longitudinal data with exogenous exposure. Biostatistics 17 (1), 122–134.
BIS, 2022. Quarterly review - international banking and financial market developments. https://www.bis.org/publ/qtrpdf.
Bluhm, C., Overbeck, L., Wagner, C., 2016. Introduction to Credit Risk Modeling. Crc Press.
Bosch, O., Steffen, S., 2011. On syndicate composition, corporate structure and the certification effect of credit ratings. J. Bank. Financ. 35 (2), 290–299.
Bozanic, Z., Loumioti, M., Vasvari, F.P., 2018. Corporate loan securitization and the standardization of financial covenants. J. Account. Res. 56 (1), 45–83.
Bruche, M., Malherbe, F., Meisenzahl, R.R., 2020. Pipeline risk in leveraged loan syndication. Rev. Financ. Stud. 33 (12), 5660–5705.
Cai, J., Eidam, F., Saunders, A., Steffen, S., 2018. Syndication, interconnectedness, and systemic risk. J. Financial Stab. 34, 105–120.
Cao, M., Xia, Q., 2021. Trust and use of covenants. Res. Int. Bus. Finance 57, 101423.
Chawla, N.V., Bowyer, K.W., Hall, L.O., Kegelmeyer, W.P., 2002. SMOTE: synthetic minority over-sampling technique. J. Artificial Intelligence Res. 16, 321–357.
Cochran, W.G., 1938. The omission or addition of an independent variate in multiple linear regression. Suppl. J. R. Stat. Soc. 5 (2), 171–176.
Crone, S.F., Finlay, S., 2012. Instance sampling in credit scoring: An empirical study of sample size and balancing. Int. J. Forecast. 28 (1), 224–238.
Crook, J.N., Edelman, D.B., Thomas, L.C., 2007. Recent developments in consumer credit risk assessment. European J. Oper. Res. 183 (3), 1447–1465.
Crouhy, M., Galai, D., Mark, R., 2000. A comparative analysis of current credit risk models. J. Bank. Financ. 24 (1–2), 59–117.
Davydenko, S., Elkamhi, R., Salerno, M., 2020. When are financial covenants relevant? Available at SSRN 3554454.

Dawid, A.P., 1979. Conditional independence in statistical theory. J. R. Stat. Soc. Ser. B Stat. Methodol. 41 (1), 1–15.
Dawid, A.P., 2000. Causal inference without counterfactuals. J. Amer. Statist. Assoc. 95 (450), 407–424.
De Franco, G., Vasvari, F.P., Vyas, D., Wittenberg-Moerman, R., 2020. Similarity in the restrictiveness of bond covenants. Eur. Account. Rev. 29 (4), 665–691.
De Novellis, G., Musile Tanzi, P., Ranalli, M., Stanghellini, E., 2024. Leveraged finance exposure in the banking system: Systemic risk and interconnectedness. J. Int. Financial Mark., Instit. Money 90, 101890.
DeFond, M.L., Jiambalvo, J., 1994. Debt covenant violation and manipulation of accruals. J. Account. Econ. 17 (1–2), 145–176.
Demerjian, P.R., 2010. Financial covenants, credit risk, and the resolution of uncertainty. In: Credit Risk, and the Resolution of Uncertainty (February 25, 2010).
Demerjian, P.R., 2017. Uncertainty and debt covenants. Rev. Account. Stud. 22 (3), 1156–1197.
Demerjian, P.R., Horne, E., Moon, K., 2020. Consequences of cov-lite loans. Available at SSRN 3588603.
Diamond, D.W., 1984. Financial intermediation and delegated monitoring. Rev. Econ. Stud. 51 (3), 393–414.
Diamond, D.W., 1991. Monitoring and reputation: The choice between bank loans and directly placed debt. J. Polit. Econ. 99 (4), 689–721.
Dichev, I.D., Skinner, D.J., 2002. Large–sample evidence on the debt covenant hypothesis. J. Account. Res. 40 (4), 1091–1123.
do Rosário Correia, M., 2008. The choice of maturity and additional covenants in debt contracts: A panel data approach. Res. Int. Bus. Finance 22 (3), 284–300.
Doretti, M., Raggi, M., Stanghellini, E., 2021. Exact parametric causal mediation analysis for a binary outcome with a binary mediator. Stat. Methods Appl. 1–22.
European Banking Authority, 2020. Leveraged finance. https://www.eba.europa.eu/, [Online; accessed 11-July-2022].
European Central Bank, 2017. Guidance on leveraged transactions. https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.leveraged_transactions_guidance_201705.en.pdf, [Online; accessed 11-July-2022].
European Central Bank, 2018. Financial stability review. https://www.ecb.europa.eu/pub/pdf/fsr/ecb.fsr201811.en.pdf, [Online; accessed 11-July-2022].
European Central Bank, 2020. Leveraged lending: banks exposed to risks amid COVID-19. https://www.bankingsupervision.europa.eu/press/publications/newsletter/2020/html/ssm.nl200513.en.html, [Online; accessed 11-July-2022].
European Central Bank, 2022. Supervising leveraged lending. https://www.bankingsupervision.europa.eu/press/speeches/date/2022/html/ssm.sp220920~d41dede079.en.html.
Federal Reserve, 2013. Interagency guidance on leveraged lending. https://www.federalreserve.gov/supervisionreg/srletters/sr1303a1.pdf, [Online; accessed 11-July-2022].
Ferrando, A., Gori, S., et al., 2022. Financing conditions through the lens of euro area companies. Econ. Bull. Boxes 8.
Financial Stability Board, 2019. Vulnerabilities associated with leveraged loans and collateralised loan obligations. https://www.fsb.org/2019/12/vulnerabilities-associated-with-leveraged-loans-and-collateralised-loan-obligations/, [Online; accessed 11-July-2022].
Fiordelisi, F., Marques-Ibanez, D., 2013. Is bank default risk systematic? J. Bank. Financ. 37 (6), 2000–2010.
Fox, S., 2023. Covenant evolution since the GFC: The potential implications of the shift in purpose from lender protections to sponsor flexibilities. J. Int. Bank. Law Regulation 38, 8.
Franz, D.R., HassabElnaby, H.R., Lobo, G.J., 2014. Impact of proximity to debt covenant violation on earnings management. Rev. Account. Stud. 19 (1), 473–505.
Giannetti, M., Laeven, L., 2012. The flight home effect: Evidence from the syndicated loan market during financial crises. J. Financ. Econ. 104 (1), 23–43.
Gietzmann, M., Isidro, H., Raonic, I., 2023. The rise of covenant-lite bond contracting. J. Account., Auditing Finance 38 (3), 483–509.
Goodell, J.W., 2020. COVID-19 and finance: Agendas for future research. Finance Res. Lett. 35, 101512.
IMF, 2016. The new basel capital accord: The devil is in the (calibration) details. https://www.imf.org/en/Publications/WP/Issues/2016/12/30/The-New-Basel-Capital-Accord-The-Devil-Is-in-the-Calibration-Details-15305.
Ivashina, V., Vallee, B., 2020. Weak credit covenants. Technical report, National Bureau of Economic Research.
Judd, C.M., Kenny, D.A., 1981. Process analysis: Estimating mediation in treatment evaluations. Eval. Rev. 5 (5), 602–619.
Lando, D., 2009. Credit Risk Modeling: Theory and Applications. Princeton University Press.
Leland, H.E., Pyle, D.H., 1977. Informational asymmetries, financial structure, and financial intermediation. J. Finance 32 (2), 371–387.
Lemmon, M.L., Zender, J.F., 2019. Asymmetric information, debt capacity, and capital structure. J. Financ. Quant. Anal. 54 (1), 31–59.
Lim, J., Minton, B.A., Weisbach, M.S., 2014. Syndicated loan spreads and the composition of the syndicate. J. Financ. Econ. 111 (1), 45–69.
LSTA, 2022. An adjustment period for the primary leveraged loan market. https://www.lsta.org/.
MacKinnon, D.P., Fairchild, A.J., Fritz, M.S., 2007. Mediation analysis. Annu. Rev. Psychol. 58, 593–614.
Mählmann, T., 2022. Negative externalities of mutual fund instability: Evidence from leveraged loan funds. J. Bank. Financ. 134, 106328.
Morais, F., Serrasqueiro, Z., Ramalho, J.J., 2022. Capital structure speed of adjustment heterogeneity across zero leverage and leveraged European firms. Res. Int. Bus. Finance 62, 101682.
Newton, D., Ongena, S., Xie, R., Zhao, B., 2020. Leveraged loans: Is high leverage risk priced in? Available at SSRN 3741693.
Nicoletti, G., Setzer, R., Tujula, M., Welz, P., 2022. Assessing corporate vulnerabilities in the euro area. Econ. Bull. Articles 2.
Nini, G., Smith, D.C., Sufi, A., 2009. Creditor control rights and firm investment policy. J. Financ. Econ. 92 (3), 400–420.
Oehlert, G.W., 1992. A note on the delta method. Amer. Statist. 46 (1), 27–29.
Ogundimu, E.O., 2019. Prediction of default probability by using statistical models for rare events. J. R. Stat. Soc.: Series A (Statistics in Society) 182 (4), 1143–1162.
Pearl, J., 2000. Causal inference without counterfactuals: Comment. J. Amer. Statist. Assoc. 95 (450), 428–431.
Pearl, J., 2009. Causality. Cambridge University Press.
Pearl, J., 2014. Interpretation and identification of causal mediation. Psychol. Methods 19 (4), 459.
Pierri, F., Stanghellini, E., Bistoni, N., 2016. Risk analysis and retrospective unbalanced data. Revstat-Stat. J. 14 (2), 157–169.
Roberts, M.R., Sufi, A., 2009. Control rights and capital structure: An empirical investigation. J. Finance 64 (4), 1657–1695.
Robins, J.M., Greenland, S., 1992. Identifiability and exchangeability for direct and indirect effects. Epidemiology 143–155.
Rubin, D.B., 2000. Causal inference without counterfactuals: comment. J. Amer. Statist. Assoc. 95 (450), 435–438.
Saona, P., Muro, L., Gregoriou, A., 2023. The phenomenon of zero-leverage policy: Literature review. Res. Int. Bus. Finance 102012.
S&P Global Market Intelligence, 2022. Leveraged loan primer. https://www.spglobal.com/marketintelligence/en/pages/toc-primer/lcd-primer, [Online; accessed 11-July-2022].
Stanghellini, E., Kateri, M., 2022. Exact mediation analysis for ordinal outcome and binary mediator. Epidemiology 33 (6), 840–842.
Sufi, A., 2007. Information asymmetry and financing arrangements: Evidence from syndicated loans. J. Finance 62 (2), 629–668.
Sun, J., Lang, J., Fujita, H., Li, H., 2018. Imbalanced enterprise credit evaluation with DTE-SBD: Decision tree ensemble based on SMOTE and bagging with differentiated sampling rates. Inform. Sci. 425, 76–91.
Tampakoudis, I., Noulas, A., Kiosses, N., 2022. The market reaction to syndicated loan announcements before and during the COVID-19 pandemic and the role of corporate governance. Res. Int. Bus. Finance 60, 101602.
Thomas, L., Crook, J., Edelman, D., 2017. Credit Scoring and Its Applications. SIAM.
Valeri, L., VanderWeele, T.J., 2013. Mediation analysis allowing for exposure–mediator interactions and causal interpretation: theoretical assumptions and implementation with SAS and SPSS macros. Psychol. Methods 18 (2), 137.
VanderWeele, T.J., 2009. Concerning the consistency assumption in causal inference. Epidemiology 20 (6), 880–883.
VanderWeele, T., 2015. Explanation in Causal Inference: Methods for Mediation and Interaction. Oxford University Press.
VanderWeele, T.J., Vansteelandt, S., 2009. Conceptual issues concerning mediation, interventions and composition. Stat. Interface 2 (4), 457–468.
VanderWeele, T.J., Vansteelandt, S., 2010. Odds ratios for mediation analysis for a dichotomous outcome. Am. J. Epidemiol. 172 (12), 1339–1348.
Venables, W.N., Ripley, B.D., 2013. Modern Applied Statistics with S-PLUS. Springer Science & Business Media.